ARS 42-37
September 1959

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

EFFECTS OF EXPOSING COTTON TO GAS PLASMAS, A PROGRESS REPORT 1/

By R. B. Stone, Agricultural Engineer, 2/
Agricultural Engineering Research Division

INTRODUCTION

An article concerning the work of O. A. Brown and associates, published in January 1957, disclosed a method of exposing seed to electromagnetic radiation. 3/ Two effects of the radiation on corn seeds were discussed. One was the increased water absorption of the irradiated corn seeds; the other was earlier germination of the treated seeds with distilled water used as the germinating medium.

However, in subsequent field tests it was found that when the water was held in tension in the soil the irradiated seeds germinated no earlier and produced no greater yield than did the control seed. Tests are being continued to determine the effects on yield of treated seed.

Experiments with irradiated soybeans likewise showed that the irradiated seed was more water absorbent than the nonirradiated seed. The water uptake of the irradiated soybeans was approximately 7 times that of the untreated soybeans after an immersion period of 4 minutes. The increase in size of the irradiated soybeans owing to water uptake occurred with such speed that the change could be noted by visible observation.

1/ The work reported in this paper is a result of cooperative research between the Farm Electrification Research Branch, Agricultural Engineering Research Division, ARS, USDA, and the Tennessee Agricultural Experiment Station, Knoxville.

2/ Located at Tennessee Agricultural Experiment Station, Knoxville.

The author wishes to thank the personnel of the Cotton and Cordage Fibers Branch, CRD, ARS, USDA, Beltsville, Md., and Knoxville, Tenn., for assistance and facilities, and to John R. Barrett, Resident Assistant Agricultural Engineer, University of Tennessee, for assistance in the yarn studies.

3/ Anonymous. Possibilities in Shock Treatment. U.S. Agr. Res. Serv., Agricultural Research 5 (7): 3-4. 1957.

Studies were also made on the effect of glow-discharge radiation on the characteristics of several other seeds.

During these experiments with cotton seeds, conducted in 1958-59, some interesting effects were discovered. This paper reports the complete results.

MATERIALS AND METHODS

Equipment for exposing materials to glow-discharge radiation and the procedure for using it have been described in detail elsewhere. 4/ However, some modifications were necessary in order to handle gin-run and mechanically delinted cotton seed expediently. For these experiments a treating chamber was constructed from 2-inch hard-glass tubing, 24 inches long and supported horizontally. The tube was closed at each end with rubber stoppers containing the electrode supports. The electrode supports were hollow, also serving as connectors to the vacuum system. Seeds were placed in a single layer along the lower tube wall between the electrodes. Acid-delinted, mechanically delinted, and gin-run cotton seeds were irradiated and studied. Exposure times of from 1 to 10 minutes were used Pressure was varied from 0.5 to 10 mm Hg, and the current range was from 10 to 50 ma.

Samples of TM 57 Pima S-1, KX De Ridder, and SO 57 DPL-15 cotton fiber were irradiated 10 minutes at 30 ma and 1 mm Hg, and sent to CRD, Cotton and Cordage Fibers Research Branch, ARS, Beltsville, Md. for analyses of cotton fiber wax, wetting rate and alkali absorption of cotton fiber.

Samples of irradiated and untreated cotton fiber were sent to the Instrumentation and Analyses Section, Southern Utilization Research and Development Division, ARS, for examination with an electron microscope.

Breaking strength tests were made on treated and untreated No. 10 Pima cotton yarn with an Instron tester at the ARS Cotton Spinning Laboratory, Knoxville, Tenn. 5/

4/ Brown, O. A., Stone, R. B., Jr., and Andrews, H. "Methods and Equipment for Low Energy Irradiation of Seeds." Agricultural Engineering 38: 666-669. 1957.

5/ Mention of a product is not to be construed as an endorsement of it by the U.S. Department of Agriculture over similar products not mentioned.

RESULTS

Acid-delinted cotton seeds following glow-discharge irradiation absorbed water over the entire surface of the seed more rapidly than did the untreated seed. When dropped into a container of water, all of the irradiated seeds sank to the bottom immediately, whereas part of the untreated cotton seeds floated on the surface for 3 to 5 minutes.

An additional discovery revealed that besides increasing the water absorbency of gin-run and mechanically delinted seeds, the glow-discharge radiation caused the cotton linters attached to these seeds to become water absorbent. The water absorption of the treated linters was very rapid and the irradiated seeds, when dropped into a container of water, sank to the bottom immediately. Nonirradiated seeds still floated on the surface of the water 24 hours after placement.

Figures 1 and 2 show irradiated and nonirradiated cotton seeds, respectively, before and after wetting.

The observations led to investigation of the effect of glow-discharge radiations on cotton fiber. Cotton fiber, which had had no processing other than ginning, was obtained and irradiated. As in the case of the linters, the irradiation of fiber made it water absorbent. Figures 3 and 4 illustrate the difference in water absorbency between treated and untreated cotton fiber, respectively.

Samples of irradiated cotton fiber were no longer soft and pliable, but were rough and stiff; it was extremely difficult to extract from them single fibers or even a group of fibers. Attempts to comb the irradiated cotton in preparation for fiber analyses resulted in excessive fiber breakage.

Figure 1...Cotton seed before wetting.
T, Treated seed; C, untreated seed.

Figure 2...Cotton seed after wetting.
T, treated seed; C, untreated seed.

Figure 3. Cotton fiber before wetting.
T, Treated fiber; C, untreated fiber.

Figure 4. Cotton fiber after wetting.
T, Treated fiber; C, untreated fiber.

The results of the analyses made at Beltsville, Md. are listed in Tables I, II, and III. They were concerned with cotton fiber wax, and wetting rate and alkali absorption of untreated and irradiated cotton fiber.

The data in Table I show that the melting range of wax of the treated fibers has been materially decreased, indicating a degradation of the wax by the electrical treatment. The data of Table II, which show a more rapid rate of wetting of treated fiber, are in good accord with these results.

TABLE I

COTTON FIBER WAX ANALYSES

Cotton		Wax: Amounts	Wax: Melting range
Variety		Percent	°C.
TM 57 Pima S-1--	Control	.73	70-77
	Treated	.71	63-69
KX 57 De Ridder-	Control	.45	70-77
	Treated	.32	62-69
SO 57 DPL-15----	Control	.60	71-78
	Treated	.51	60-70

TABLE II

WETTING RATE OF COTTON FIBER

Cotton		Sinking Time in 50% ethyl alcohol	
Variety		Seconds	Seconds
TM 57 Pima S-1--	Control	5	5
	Treated	1	1
KX 57 De Ridder-	Control	6	6
	Treated	1	1
SO 57 DPL-15----	Control	6	8
	Treated	1	1

Table III presents the data from an alkali-centrifuge test. 6/ These figures indicate that the treatment has weakened the cellulose of the outer wall of the fiber, which provides less resistance to the swelling of the underlying cell wall and results in a greater amount of alkali absorption.

6/ Marsh, P.B., Merola, G.V., and Simpson, M.E. "Experiments with an Alkali Swelling-Centrifuge Test Applied to Cotton Fiber." Textile Res. Journal 23(11): 831-841. November 1953.

TABLE III

ALKALI ABSORPTION OF COTTON FIBER

Cotton	Alkali-centrifuge value (average)	
Variety	Control	Treated
TM 57 Pima S-1---	169	283
KX 57 De Ridder--	170	248
SO DPL-15--------	185	259

Photographs of the irradiated and untreated cotton fiber, as seen through the electron microscope, were taken by the Southern Utilization Research and Development Division during examination of the samples submitted. Figures 5 and 6 are micrographs of treated and untreated cotton fiber, respectively. Note the broken surface areas of the treated fiber.

Figure 7, a micrograph of the primary wall from treated cotton fiber, shows the change in the appearance of the surface of the fiber caused by the electrical treatment. Figure 8 shows the primary wall from untreated cotton fiber.

The next step in the investigation was to examine the effect of the glow-discharge plasma on cotton fibers spun into yarn. Samples of cotton yarn were obtained and subjected to the glow-discharge treatment. The treated yarn had a more rapid rate of water absorption than did the untreated yarn. The breaking strength of the treated yarn was found to be 1,697 grams compared with 1,382 grams for the untreated yarn. The figures are an average of 25 breaks which were made at the ARS Cotton Spinning Laboratory.

An intensive study is being made of the effects of the glow-discharge treatment on the characteristics of cotton fiber and cotton yarn. In addition, cooperative field tests have been instituted with the Crops Research Division in Tennessee and Mississippi, and the Tennessee and New Mexico Agricultural Experiment Stations to determine what effect the treatment of cotton seeds may have on emergence, survival, growth, and yield of cotton.

Figure 5. Micrograph of surface of treated cotton fiber.

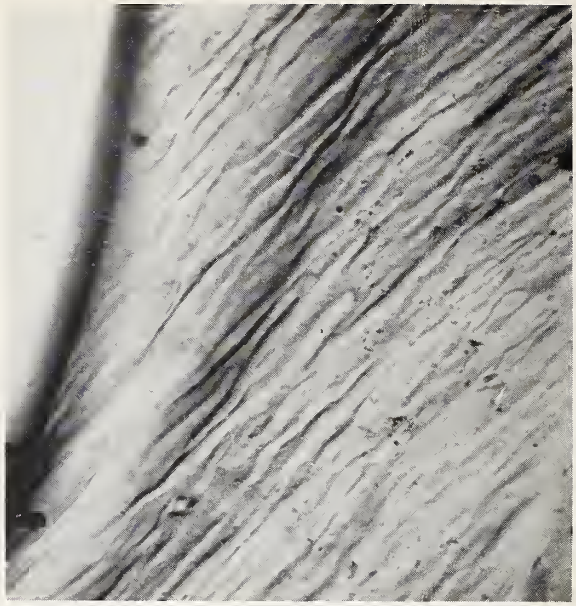

Figure 6. Micrograph of surface of untreated cotton fiber.

Figure 7. Primary wall from treated cotton fiber.

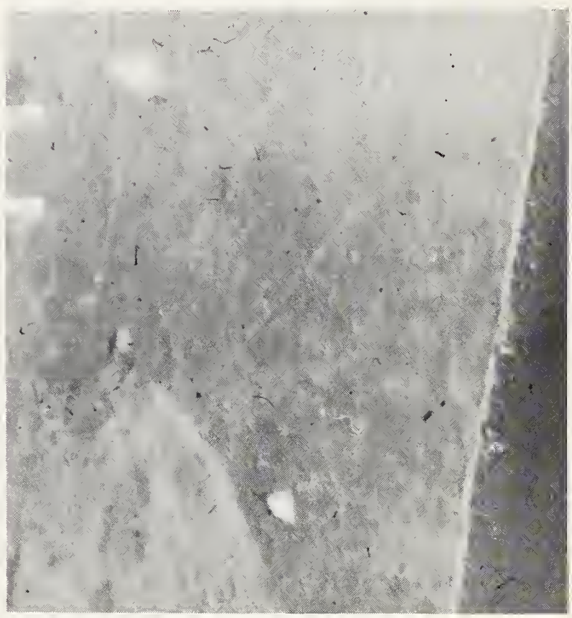

Figure 8. Primary wall from untreated cotton fiber.

Photos on this page were taken by Southern Utilization Research and Development Division